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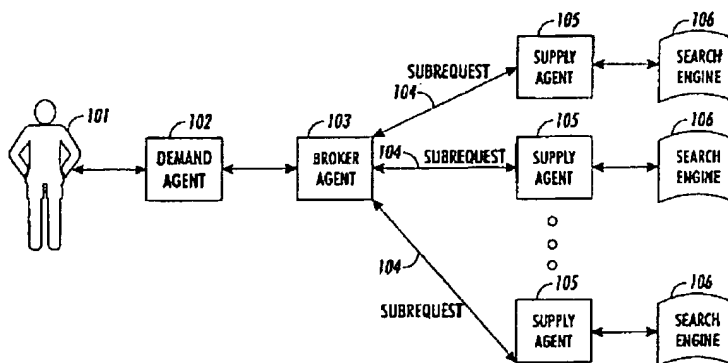
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(54) **Search channels between queries for use in an information retrieval system**

(57) An information retrieval system (102-105) for retrieving information from multiple information sources. The information retrieval system provides for the building of dynamic queries through the use of query channels. A query channel permits the passing of attributes of the search results between different queries. The query channel can cause the automatic passing of the attributes, or it can be user controlled (breakpoints). Further, the query results may be transformed so that they are in the context of the target query (computational

transformations). For example, the results may be translated or reformatted into a form utilized by the target query. Query channels are created based on graphical representations of queries and their attributes. A simple drag and drop operation, wherein an attribute is selected and dragged to the target query, is used to create the channel. A channel may be created while a query is running. Specification of breakpoints or computational transformations are made using a pop-up window interface that may appear when the channel is selected.



**FIG. 1**

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**Description**

[0001] The present invention is related to the searching of information repositories such as databases, and in particular to a facility for generating and building dynamic queries.

[0002] When accessing heterogeneous legacy databases on Intranets or while querying multiple information sources on the Internet, the end-user only wants to have a simple and straightforward point of access.

[0003] An exemplary information retrieval architecture is described in the article entitled "System Components For Embedded Information Retrieval From Multiple Disparate Information Sources", Ramana B. Rao, Daniel M. Russell, and Jock D. Mackinlay, Proceedings of 1993 ACM Symposium on User Interface Software and Technology, Atlanta, GA, November 1993 ACM SIGGRAPH and SIGCHI. The architecture incorporates an intermediary server which mediates access requests between an information access client (i.e. the user) and various information sources. Thus, the user only needs to interface with the information access client in order to retrieve the information from multiple information sources.

[0004] Another difficulty in information retrieval is query generation. The process of generating an effective query is often an iterative one. In such a process, the results of one query are then used to formulate a second, often more narrow query. This occurs because the first query may have been too broad in scope and had returned large amounts of unusable or redundant data. Moreover, known query systems are "static" in nature. In other words, in order for query to begin, all of the query terms must be fixed. However, because of the vast amount of information constantly becoming available on the World Wide Web, it would be desirable to make queries more dynamic in nature. Further, since the information repositories are disparate, portions of the query may be running in parallel. Thus, it would be desirable to be able to specify and execute a query that is dynamic in nature so that search terms are not static.

[0005] The present invention is related to the searching of network accessible distributed databases, such as those found on the Internet. Drag and drop search channels are described which enable the combining of queries. A query is visually displayed on the display of a computer system as a query window. The query window will provide for the input of attributes that define the nature and scope of intended query. The attributes may be logically combined to create the intended query. Each attribute specification is represented as an object. In order to include an attribute of a first query as an attribute of a second query, a user selects an attribute, wherein a graphical representation of the attribute is created. The user then "drags and drops" the graphical representation of the attribute to an attribute specification area of the second query. Thus, a channel of communication between two queries is established which can

have the properties described below.

[0006] The Drag and Drop Search channels provide Computational Transformations. Computational Transformations allows for the automatic adaptation of the results associated with a channel to the query context.

[0007] The Drag and Drop Search channels further provide for the ability to create compound queries dynamically and incrementally and further provide breakpoints so that search results may be operated on and manually filtered by the user.

Figure 1 is a block diagram illustrating the components of and process flow for an information retrieval system of the currently preferred embodiment of the present invention;

Figures 2 and 3 illustrate simple and complex query windows as may be utilized in the currently preferred embodiment of the present invention;

Figures 4 and 5 illustrate simple and complex result windows as may be utilized in the currently preferred embodiment of the present invention;

Figures 6 and 7 illustrate by way of sample screen displays, an example of the creation of channels between queries, as may be performed in the currently preferred embodiment of the present invention;

Figure 8 illustrates by way of a sample screen display, a user interface for specifying computational transformations or breakpoints in a channel between queries, as may be performed in the currently preferred embodiment of the present invention;

Figure 9 illustrates the data structure for a complex query which is used to show the channel relationship between queries, as may be used in the currently preferred embodiment of the present invention; and,

Figure 10 is an illustration of a computer-based system as may be used to implement the currently preferred embodiment of the present invention.

[0008] The present invention is directed to an interface for query generation to and information retrieval from one or more information sources. The currently preferred embodiment is implemented in an information retrieval system which provides software agents that can query multiple heterogeneous databases, reconstruct information and generate customized reports. A description of the system is provided below, while a more comprehensive description of the time of filing this application can be found on the World Wide Web at URL <http://www.xerox.com/research/ci/research/cbkb.html>.

[0009] The present invention builds on the system by providing a facility to build dynamic complex queries. A dynamic complex query is one where query attribute specification is dynamic, rather than static, so that the results (or partial results) of one query can be used as an attribute specification by another query. Furthermore, the facility is made available to a user in a very

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intuitive fashion using well-known drag and drop graphical user interface methods.

[0010] The currently preferred embodiment of the present invention can be implemented for use on computer based systems capable of accessing the World Web (the Web) using a suitable Java™ enabled Web Browser. The various software programs utilized in the implementation are written in the well-known Java programming language.

[0011] The amount of information available from electronic sources on the World Wide Web or other on-line information repositories is increasing exponentially. Tools are needed to extract relevant information from these repositories. The information retrieval system sophisticated facilities for efficient information retrieval and combination. Figure 1 illustrates how information requests are processed in the information retrieval system. Referring to figure 1, a user 101 requests information through a Demand Agent, 102. The Demand Agent 102 typically embodies a User Interface which is presented to a User. In the currently preferred embodiment, the Demand Agent 102 is a Java™ Applet which is downloaded to User's personal computer system and is accessible using a suitably configured Web Browser (such as Netscape Navigator® having the appropriate Java™ software capabilities)

[0012] Demand Agents 102 will then present the information request to a Broker Agent 103. The Broker Agents 103 decompose information requests into interdependent subrequests 104. The requests or subrequests that cannot be further decomposed are fed into Supply Agents 105 that access electronic information repositories through search engines 106. The Supply Agents 105 will typically be configured to interface using the protocols of a particular search engine 106. For example, a Supply Agent may be provided to interface and make requests to the Alta Vista™ search engine. In the currently preferred embodiment, the Broker Agents and Supply Agents will operate on a Server system which provides information retrieval.

[0013] The results of the information request are received and then recomposed by the Broker Agent 103. It should be noted that the information retrieval system will provide for advanced querying facilities for the user not provided by some information sources, so the recomposition includes further filtering of the results to enable the advanced querying facilities. The recomposition may further include such tasks as formatting the received information and/or ranking the results with respect to the query request. Once the recomposition is completed, the results are returned to the Demand Agents 102 for presentation to the user 101.

[0014] It should be noted that preferably, requests, information and results are represented via feature constraints. Requests do not need to be fully defined; they may correspond to partial specifications of the requested information. Furthermore, requests that cannot be fully satisfied may still obtain results in the form of partial

objects that refine the initial requests by instantiating some of its attributes or by adding new attributes, thus providing user feedback.

[0015] Various aspects of the information retrieval system can be found in the following PCT Publications WO 98/48359 (29 October 1998) and WO 98/48361 (29 October 1998).

[0016] Each of the various agents described above are preferably embodied as software programs, written in the Java programming language for execution on suitably configured computer based systems.

[0017] Figure 2 is an illustration of a query window for specifying a query. Referring to Figure 2, a domain area 201 of query window 200 provides a means for specifying one of a plurality of predetermined domains for the query. The query domain relates to the type of information being sought. For example, a query domain may be a type of documents (e.g. books or articles) or a subject area (e.g. physics or operas). In the currently preferred embodiment, these domains are predefined and correspond to one or more information sources to which the query will be directed. The areas 202-204 provide for specifying a search pattern. The area 202 is for specifying a predetermined attribute (e.g. title or author). The area 203 is for specifying a constraint (e.g. contains or matches exactly) which is to be placed on the attribute and a specified keyword. The area 204 is for specifying a desired keyword(s), which may define an expression formed by keywords and Boolean operators. If the search pattern is correct, pressing the button 205 labeled "Add to the Specification" causes the pattern to be added to the current specification of the query, as indicated in specification area 206. If the search pattern is not correct, it can be reset using a reset button 207. The specification area 206 includes all the desired search patterns specified by the user.

[0018] Buttons 208-211 provide for editing the specification. Button 208 provides for editing a selected search pattern. Button 209 provides means for removing a search pattern. Button 210 provides means for clearing the entire specification. Button 211 provides for cancellation of a sub-query.

[0019] Finally, buttons 212-213, respectively, provide for the control of submission and cancellation of a query. Figure 3 illustrates a window for performing a sub-query within a query, i.e. a complex query. In a complex query, a subquery generates a set of subresults. The results generated are subresults in the sense that they deliver values that will be used in the query pattern of the main query (or in general a higher level query). A sub-query is provided for by selecting a predetermined option in the area 203, namely the "answer of" option. This causes the window of Figure 3 to be displayed. As can be seen in figure 3, a new Tab 301 has been included to indicate that it is a sub-query. This also enables the user to traverse between the main query and the sub-query. Note that the rest of the sub-query window is similar to the main query.

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[0020] Figures 4 and 5 illustrate summary and detail views of the result window from a search. Referring to Figure 4, a summary view shows a list of all the hits and some overall summary information such as the number of hits. In Figure 5, all information fields relating to a particular "hit" are displayed. A body area 501 shows the textual content of the document. Information area 502 provides various information such as date, URL location, information source, size and title. In this view, traversal through the list of hits is provided previous 503 and next 504 buttons provided within the window.

[0021] Establishing a Drag-and-Drop Channel between two queries amounts to an instruction to pass answers, returned for an attribute field of the source query, as input values for an attribute field in the target query. In one respect, this is conceptually analogous to the relationship between a query and a sub-query. However, the Drag and Drop Channel of the present invention, provides further functionality. The Drag-and-Drop Channels provide :

- living links between queries which allow the user to construct compound queries dynamically and incrementally,
- computational transformations which allow the user to automatically adapt the dragged-and-dropped attribute values to the query context, and
- breakpoints for user intervention into the search process which allow the user to filter the values passed along the Drag-and-Drop Channels.

[0022] Living links between queries allow the user to construct compound queries dynamically and incrementally. The user can introduce Drag-and-Drop Channels between queries not only *a priori*, but also *a posteriori* with respect to launching the involved queries.

[0023] Usually, e.g. with Structured Query Language (SQL), the definition of compound queries must be done *a priori*. The user must know in advance how they will link several queries to obtain what they are searching for so the user defines all involved queries and links them before launching the whole compound query.

[0024] But this is not always the natural way to create compound queries. Often the inspection of query results leads to new ideas on how to use them. But, using already obtained query results as input for another query is only possible, if queries can be combined dynamically. This is possible through Drag-and-Drop Channels. They can be established *a posteriori*, when the source query is already (and continuously) running. This *a posteriori* operation is enabled as a result of a feature provided in the information retrieval system wherein query results may be continually accumulated (i.e. query results may be continuously returned as a result of new documents being placed within the query domain).

[0025] If the Drag-and-Drop Channel is introduced *a posteriori*, the already present results are immediately forwarded to the target query. In any case, all the results

arriving after introduction of the Drag-and-Drop Channel are forwarded as they arrive.

[0026] Computational Transformations provide for the automatic adaptation of the dragged-and-dropped attribute values to the query context. Passing the values from the source attribute of the Drag-and-Drop Channel to its target attribute is not always immediately possible. Problems arise, e.g. if the source and target attributes do not have the same type, arity or unit, or if the general context of the linked queries is different. Then computational transformations are necessary to enable the value passing between the queries. Below are examples of computational transformations:

#### Example (attribute type integration)

[0027] If you drop an integer attribute on to a string attribute, you have to transform the integer values of the output attribute field to a string value for the input attribute field.

#### Example (attribute arity integration)

[0028] If the arity of the linked attributes is not the same, especially if the source attribute of the Drag-and-Drop Channel contains a *list of values* and the target attribute expects *single values*, then these single values must be extracted from the list before they can be passed to the target query. E.g. if you drop an attribute whose value contains name *lists* (composed for example of all co-authors of found articles) on an attribute which expects *single names* (e.g. to search for the person's homepage), then you first have to extract the elementary (sur-)names of the authors, and pass them one-by-one to the input attribute field.

#### Example (attribute unit integration)

[0029] If the units of the source and the target attribute are different, the values to drop can be automatically calculated, e.g. multiply by 1000 to transform 1 km into 1 000 m, or divide by 60 to transform 1 minute into 1/60 h.

#### Example (linguistic integration)

[0030] The transformations can also be determined by other characteristics of the linked queries, such as their language. If for each query the language is defined (or can be inferred by language guessing for example), and two queries in different languages are linked, then the transformation consists for example in translating the values from the language of the source query to the language of the target query. A manner of performing such cross-lingual information retrieval is described in a copending U.S. Patent Application entitled: "System For Providing Cross-Lingual Information Retrieval", serial no. Not Yet Assigned.

[0031] If the characteristics of the source and target

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attributes and queries is known by the system, then these computational transformations can be automatically introduced. Otherwise they can be user defined.

[0032] Drag-and-Drop Channels constitute possible breakpoints for user intervention into the search process. In fact, often the user does not want to *automatically pass all the values* found for the source attribute of the Drag-and-Drop Channel to its target attribute. Instead, the user wants to *control* this process and to *filter* the values manually. Therefore a Drag-and-Drop Channel can be *automatic* or *user-controlled*. The user can specify for each Drag-and-Drop Channel if the values shall pass automatically or if the user wants to filter them.

[0033] This is especially useful if the query results of the source query have low precision, i.e. if many of the documents in the query result are not adequate for use as input into a subsequent query. If all inadequate values are automatically passed to the subsequent searches, the final results of the compound query would get a very low precision. Thus, making a Drag-and-Drop Channel user-controlled, allows the user to improve the precision of the final results. Furthermore it improves the efficiency of the search process as it also reduces the number of queries generated by the passed values.

[0034] The usage of Drag-and-Drop Channels as user filtering points extends also the functionality of a Drag-and-Drop Channel introduced *a posteriori*: before establishing the Drag-and-Drop Channel by dragging the source attribute onto the target attribute, the user might want to suppress some inadequate results or attribute values. This corresponds to a *posteriori* filtering. In consequence the afterwards established Drag-and-Drop Channel is a user-controlled one.

[0035] Figures 6-7 are illustrative screen displays indicating how channels between queries are created. Referring to Figure 6, the "author" attribute 611 of query 1 601 has been linked to query 4 604. Here, the author attribute 612 of query 2 602 is also to be linked as an attribute of query 4. As indicated by the highlighting, the author attribute has been selected and is being moved via a drag and drop user interface operation. Figure 7 illustrates the results wherein query 4 604 now also contains the results of the author attribute 612 of query 2 602 are included as an attribute of query 4 604.

[0036] Figure 8 is an illustrative screen display showing an interface for specifying operational characteristics of a channel between queries. Referring to Figure 8, assuming that the channel with query 2 has been selected and a user interface action, such as a double mouse click, has been performed to cause a pop-up control window 800 be displayed. This pop-up control window is used to select the various control features for a channel. So for example, a first selection area 801 has check boxes 801 and 802 which permits one to select between automatic or user controlled transfer of attribute query results. This is the manner in which breakpoints can be introduced in the target query (in this case query 4).

[0037] A second selection area 806 has a check box 804 that is used to specify if it is desirable to automatically transform the attribute results to be in the target query context. Here, the transformation is automatically identified 805 based on the source and target query context (e.g. query 2 presents retrieves Author information in List format, whereas query 4 retrieves Author information in single name format). The above is but one way of how operational characteristics of a link can be specified and is not meant to be limit the scope of the present invention. Other ways could be utilized, such as through a control checkbox associated with a channel, and would not cause departure from the spirit and scope of the present invention.

[0038] It should be noted that the user interfaces illustrated in Figures 6-8 would typically be presented to a user through a Demand Agent, as illustrated in Figure 1.

[0039] Figure 9 is an example of a data structure for a complex query showing the relationship of channels between queries. It should be noted that a simple query would typically have a structure found in one of the sub-queries described in Figure 9. In any event, referring to Figure 9, lines 901-905 define the parts of the query. In this case, three (3) sub-queries are defined along with two (2) computational transformations. The definition of query 1 begins at line 906 and ends at line 916. From these lines it is shown that Query 1 has a domain of "computer science", a query attribute wherein the title contains the string "database systems" and a query attribute of author which is filled in by the query. A computational transformation of type "nameExtraction", is performed on the content of the author attribute and stored in a location indicated as "A11" (lines 911-916).

[0040] The definition of query 2 begins at line 917. The domain of query 2 is "computer science" and the title should have the word "constraints" in it. In query 2, the author attribute is subject to the same computational transformation as found in query 1 Lines 922-926).

[0041] Finally, the query 3 begins on line 927. In query 3, the domain is "computer science" and the author attribute contains the results of the author attributes of queries 1 and 2. This is the channel established between query 3 and each of queries 1 and 2.

[0042] Typically, the data structure of Figure 9 would be interpreted by a broker agent as illustrated in Figure 1.

[0043] The computer-based system on which the currently preferred embodiment of the present invention may be implemented is described with reference to Figure 10. For example, the computer based system 10 may embody a user system upon which a demand agent executes and the user interface presented to a user, or it may be server system wherein the various broker and supply agents would execute. In any event, referring to Figure 10, the computer-based system is comprised of a plurality of components coupled via a bus 1001. The bus 1001 illustrated here is simplified in order not to obscure the present invention. The bus 1001 may consist

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of a plurality of parallel buses (e.g. address, data and status buses) as well as a hierarchy of buses (e.g. a processor bus, a local bus and an I/O bus). In any event, the computer system is further comprised of a processor 1002 for executing instructions provided via bus 1001 from internal memory 1003 (note that the internal memory 1003 is typically a combination of Random Access or Read Only Memories). The processor 1002 and internal memory ROM 1003 may be discrete components or a single integrated device such as an Application Specification Integrated Circuit (ASIC) chip which has been designed to embody the functional features of the present invention.

[0044] Also coupled to the bus 1001 are a keyboard 1004 for entering alphanumeric input, external storage 1005 for storing data, a cursor control device 1006 for manipulating a cursor, and a display 1007 for displaying visual output. The keyboard 1004 would typically be a standard QWERTY keyboard but may also be telephone like keypad. The external storage 1005 may be fixed or removable magnetic or optical disk drive. The cursor control device 1006 will typically have a button or switch associated with it to which the performance of certain functions can be programmed. The network connection 1008 would be used to receive and/or transmit data containing a bit-mapped representation of a medium.

#### Claims

1. An information retrieval system for generating queries to one or more information sources, said information retrieval system comprising:

a demand agent (102) providing:

a user interface for allowing a user to specify a search expression;  
a query specification interface for allowing a user to specify a channel between a first query and a second query wherein the search results for an attribute of said first query are provided as an attribute of said second query;

a broker agent (103) providing

a search and retrieval element for processing a search expression and creating specific information source search requests;  
a channel element for associating the results of an attribute of said first query with said second query; and  
a supply agent (105) for receiving said search requests and requesting and obtaining documents from information sources responsive to said search requests.

2. The system as recited in claim 1, wherein said demand agent (102) is further comprised of a channel control interface for causing user controls on said channel, wherein a first user control is a computational transformation for transforming the results of the search for said first attribute into the query context of said second query; and wherein said broker agent (103) is further comprised of an element for causing an associated computational transformation to occur.

3. The system as recited in claim 2, wherein said computational transformation is one of a translation from a source language to a target query language, an attribute type integration, an attribute arity integration, and an attribute unit integration.

4. A method for obtaining information from one or more information sources from an information retrieval system, said method comprising the steps of:

a) a user specifying one or more query attributes for a first query;  
b) said user specifying a second query, wherein in at least one of said attributes for said second query is the results of a query attribute from said first query;  
c) said information retrieval system providing the results of said first query;  
d) said information retrieval system extracting from the results of said first query, the results for said specified query attribute;  
e) said information retrieval system providing said results for said specified query attribute as a result for said second query; and  
f) said information retrieval system providing said user with the results of said second query.

5. A program storage device readable by a machine, tangibly embodying a program of instructions executable by the machine to perform method steps for obtaining information from one or more information sources from an information retrieval system, said method comprising the steps of:

a) a user specifying one or more query attributes for a first query;  
b) said user specifying a second query, wherein in at least one of said attributes for said second query is the results of a query attribute from said first query;  
c) said information retrieval system providing the results of said first query;  
d) said information retrieval system extracting from the results of said first query, the results for said specified query attribute;  
e) said information retrieval system providing said results for said specified query attribute as

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a result for said second query; and  
f) said information retrieval system providing  
said user with the results of said second query.

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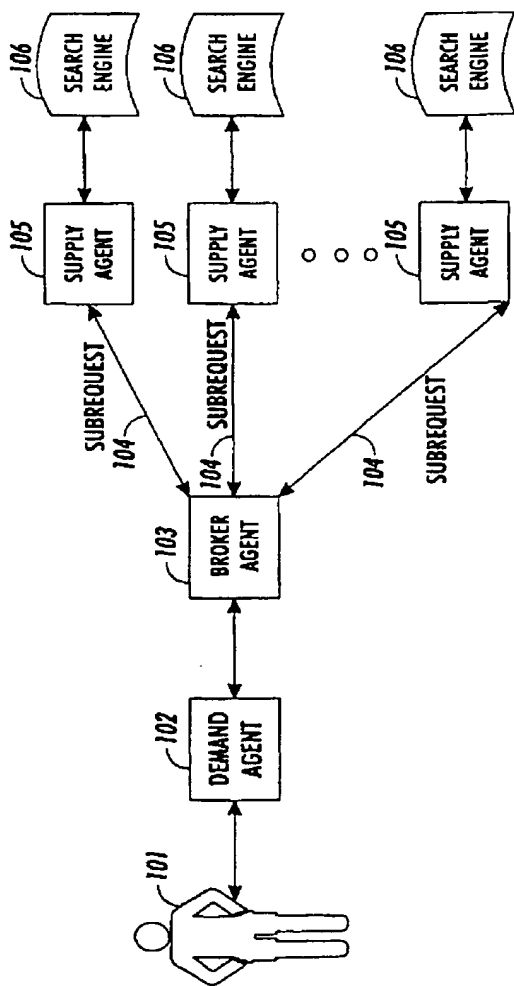


FIG. 1



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MAINQUERY

QUERY CONCERNING BOOKS/ARTICLES

TITLE CONTAINS -- AND/OR --

RESET ADD TO SPECIFICATION

CURRENT SPECIFICATION:

TITLE CONTAINS AGENTS

TITLE CONTAINS WEB OR INTERNET

DATE AFTER 06.95

EDIT REMOVE CLEAR CANCEL SUBQUERY

GLOBAL OPTIONS:

☐ CASE SENSITIVE SEARCH

☐ SEARCH ALSO WEBCRAWLERS

SUBMIT CANCEL

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FIG. 2

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301

<b>MAINQUERY</b>		<b>SUBQUERY 1</b>	
QUERY CONCERNING		OPERAS <input type="text"/>	
COMPOSER <input type="text"/>	CONTAINS <input type="text"/>	WAGNER	
<input type="button" value="RESET"/> <input type="button" value="ADD TO SPECIFICATION"/>			
<input type="button" value="EDIT"/> <input type="button" value="REMOVE"/> <input type="button" value="CLEAR"/> <input type="button" value="CANCEL SUBQUERY"/>			
GLOBAL OPTIONS:			
		<input type="checkbox"/> CASESENSITIVE SEARCH	
		<input type="checkbox"/> ALSO SEARCH WEBCRAWLERS	
<input type="button" value="SUBMIT"/> <input type="button" value="CANCEL"/>			

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**FIG. 3**

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RESULTS OF QUERY 1 (BOOKS/ARTICLES) : DATE AFTER 9506 ...

SHOW ☐ SUMMARY ☐ USING ☐ TITLE ☐ NB OF HITS: 24

HIT 1: GENERAL AGENTS WEB SERVICE MAINPAGE  
HIT 2: IWAH - INTELLIGENT WEB AGENTS / HOUSTON  
HIT 3: PERSISTENT JAVA AND MOBILE WEB AGENTS  
HIT 4: REAL ESTATE AGENTS WEB PAGES CREATED BY INNOVATIVE...  
HIT 5: INTERNET AGENTS: SPIDERS, WANDERERS, BROKERS, AND 'BOTS/FAH-CHENG  
HIT 6: PROGRAMMING INTELLIGENT AGENTS FOR THE INTERNET/MARK WATSON  
HIT 7: GENERAL AGENTS WEB SERVICES MAINPAGE  
HIT 8: INTERACTIVE HOME BUYING ON WEB - REAL ESTATE AGENTS & COMPANIES  
HIT 9: HTML WEB PAGE DESIGN AND MARKETING AGENTS  
HIT 10: ETHICAL WEB AGENTS  
HIT 11: TAHITIWEB - TAHITI AND ITS ISLANDS WEB PAGES - TRAVEL AGENTS  
HIT 12: WWW-VRML OCT-DEC 1995: INTERACTIVE AGENTS AND THE WEB  
HIT 13: WWW-VRML OCT-DEC 1995: RE: INTERACTIVE AGENTS AND THE WEB  
HIT 14: DARTFLOW: A WORKFLOW MANAGEMENT SYSTEM ON THE WEB USING TRANSP  
HIT 15: TRAVEL AGENTS INTERNET MAILING LIST  
HOT 16: INTERNET AGENTS (BOOK OUTLINE)

ALPHABETIC SORT ☐ QUALITY SORT ☐

ALL TO HTML ☐ SELECTED TO HTML ☐ DELETE SELECTED HITS ☐ UNSELECT ALL ☐

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FIG. 4

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RESULTS OF QUERY 1 (BOOKS/ARTICLES): TITLE CONTAINS WEB OR INTERNET ...

SHOW ☐ ALL FIELDS OF ☐ MAINQUERY NB OF HITS: 25

**HIT 8**

501 BODY

WELCOME TO THE GENERAL AGENTS WEB SERVICES  
MAINPAGE. WE ARE A FULL-SERVICE WEB DESIGN AND  
HOSTING SERVICE. PLEASE CHOOSE ONE OF THE  
FOLLOWING LINKS FOR ...

502

DATE	09.05.96
HTTP_URL	<a href="http://www.generalagents.com/">HTTP://WWW.GENERALAGENTS.COM/</a>
INFORMATION_SOURCE	ALTA VISTA (DIGITAL)
SIZE	2K
TITLE	GENERAL AGENTS WEB SERVICES MAINPAGE

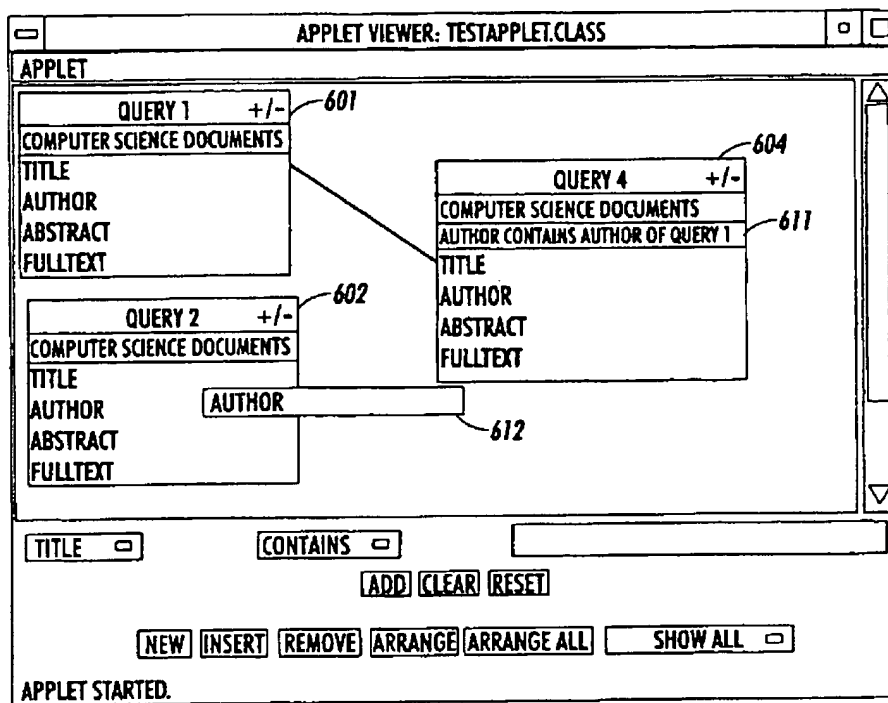
503 PREVIOUS ... 504 NEXT ... GO TO:  QUALITY SORT

ALL TO HTML SELECTED TO HTML DELETE SELECTED HITS UNSELECT ALL

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FIG. 5

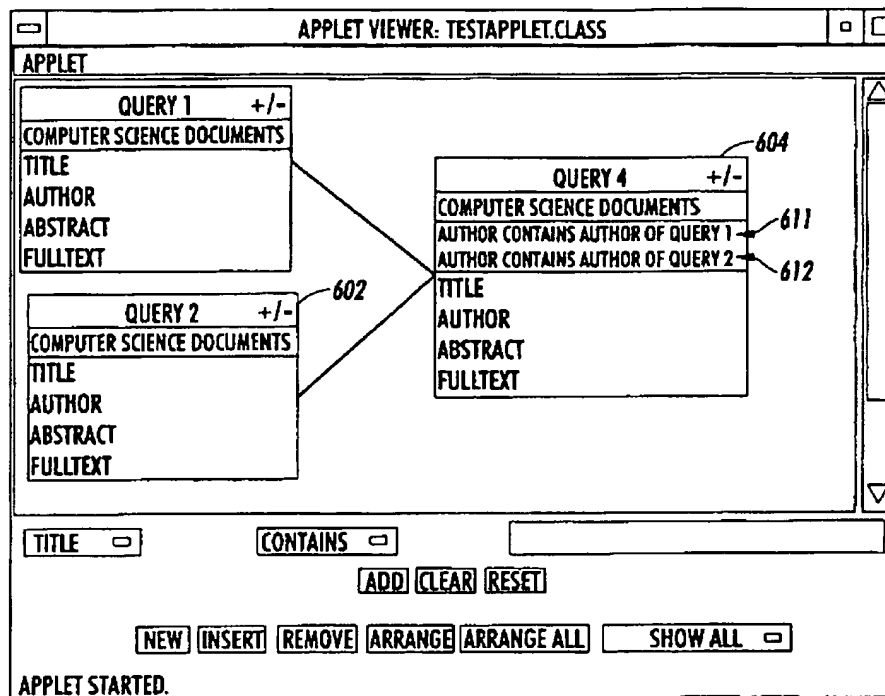
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FIG. 6

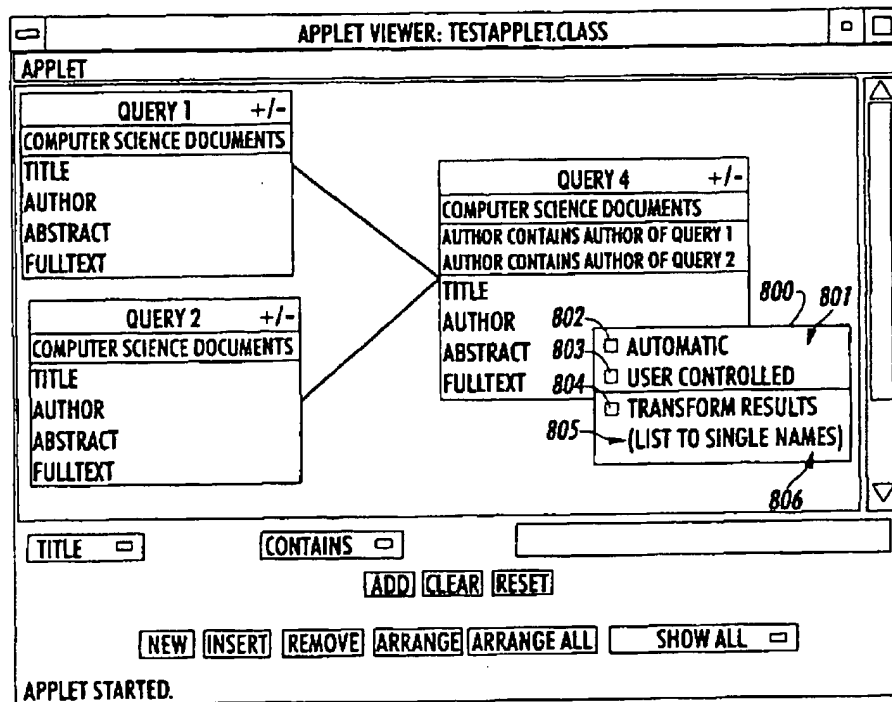
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FIG. 7

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FIG. 8

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901 CompQuery: part1 -> QUERY1 //CompoundQuery contains a query QUERY1
902 CompQuery: part2 -> QUERY2 //CompoundQuery contains a query QUERY2
903 CompQuery: part3 -> QUERY3 //CompoundQuery contains a query QUERY3
904 CompQuery: part4 -> CT1 //CompoundQuery contains a computational transformation CT1
905 CompQuery: part5 -> CT2 //CompoundQuery contains a computational transformation CT2
906 QUERY1: domain -> D1 //QUERY1 has a domain D1
907 D1 == "computer science" //which is "computer science"
908 QUERY1: title -> T1 //QUERY1 has a title T1
909 T1 contains TC1 //whose value contains [should contain]
910 TC1 == "database systems" //the string "database systems"
911 QUERY1: author -> A1 //QUERY1 has also an author A1
912 // - which will be filled by the query results
913 CT1: domain -> CTD1 // the computational transformation CT1
914 CTD1 == "nameExtraction" //is of type nameExtraction
915 CT1: nameList -> A1 //it will extract all names from A1
916 CT1: name -> A11 // and provide the values as result in A11
917 QUERY2: domain -> D2
918 D2 == "computer science"
919 QUERY2: title -> T2
920 T2 contains TC2
921 TC2 == "constraints"
922 QUERY2: author -> A2
923 CT2: domain -> CTD2
924 CTD2 == "nameExtraction"
925 CT2: nameList -> A2
926 CT2: name -> A21
927 QUERY3: domain -> D3
928 D3 == "computer science"
929 QUERY3: author -> A3
930 A3 contains A11 //A11 is used as input in QUERY3
931 A3 contains A21

```

FIG. 9



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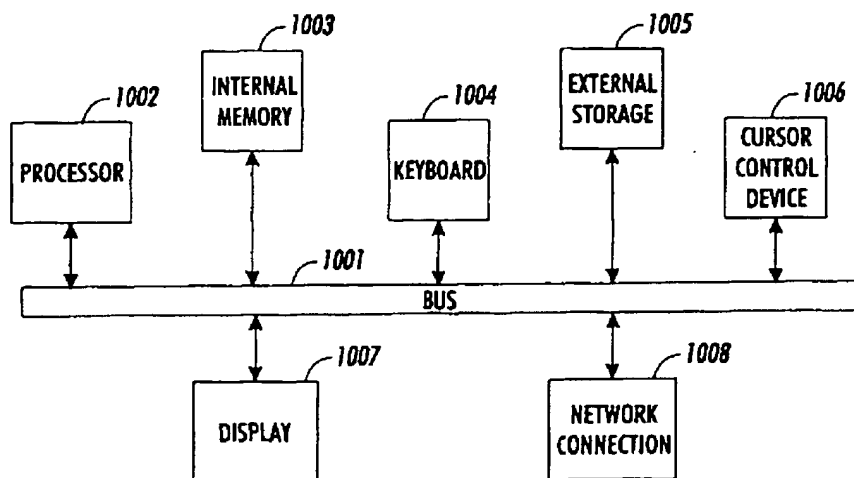


FIG. 10

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Application Number  
EP 99 31 0164

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